10/803 567 E
Sep 27 2004

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 336 530 A2**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 89301113.0

(22) Date of filing: 06.02.89

(51) Int. Cl.4: H02K 11/00

(30) Priority: 07.04.88 GB 8808146
24.05.88 GB 8812283

(43) Date of publication of application:
11.10.89 Bulletin 89/41

(84) Designated Contracting States:
DE ES FR SE

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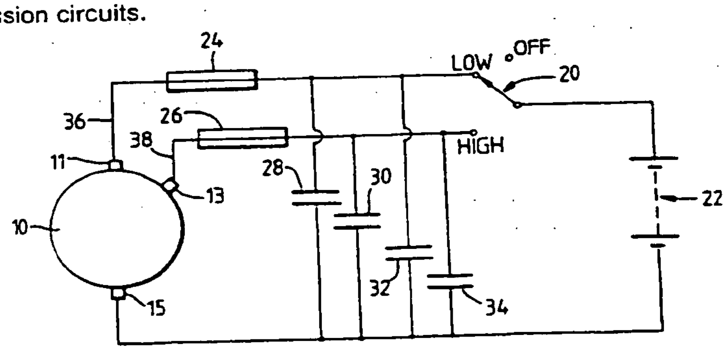
(54) Radio interference suppression.

(57) An arrangement for the suppression of radio interference in an electric motor (10) having at least two brushes (11,13,15), the arrangement comprising a high frequency interference suppression circuit and a low frequency interference suppression circuit, the high frequency interference suppression circuit comprising a ferrite bead (24,26) which surrounds a portion of a lead (36,38) connectable to one (11,13) of the brushes, and a capacitor (28,30) which is capable of self resonance in the high frequency band, and the low frequency interference suppression circuit comprising a capacitor (32,34). Also discloses an isolating element between the low frequency and high frequency suppression circuits and a separate pounding method for each circuit for reducing the interaction between the high frequency and the low frequency suppression circuits.

Fig.2.



EP 0 336 530 A2

RADIO INTERFERENCE SUPPRESSION

This invention relates to an arrangement for the suppression of radio interference from electric motors, and in particular from electric motors having automotive applications such as in windscreen wiper circuits and heater blower circuits. These electric motors generate electrical noise because of the sparking at the brush/commutator interface. This electrical noise is coupled to the motor vehicle radio receiver by radiation, conduction, or common impedance coupling, causing interference with radio reception.

It is usual practice to include suppression circuit elements with the wiring elements for electric motors which reduce or eliminate interference noise on the radio receiver. These circuit elements usually consist of inductors and capacitors which attenuate the noise voltage, but have little or no effect on the d.c. supply voltage to the electric motor. Because of their construction it is not possible to use only a simple inductor or capacitor to attenuate the noise voltage at all frequencies. For example, a capacitor which can attenuate the noise voltage in the lower radio frequency bands (AM band) of 140 KHz to 1.6 MHz has little or no effect in the higher radio frequency bands (FM band) of 86 MHz to 108MHz. The capacitor may even cause the noise voltage to increase at frequencies other than those for which it is designed to suppress. This problem occurs because the capacitor can resonate with other circuit elements at certain frequencies causing noise peaks in other radio frequency bands. This interaction between circuit elements is a common problem which limits the use of cost effective components for interference suppression.

Further, it is also the usual practice to use wire wound chokes as the inductors, and to mount these chokes, inside the housing of the electric motor, with the capacitors connected in the wiring circuit which connects the electric motor to the d.c. supply voltage. The use of chokes as inductors, and the positioning of the capacitors does not lend itself to automatic assembly of the suppression circuit elements.

It is an object of the present invention to provide an arrangement for radio interference suppression which has a cost advantage over previously known arrangements, and which lends itself to automatic assembly.

An arrangement in accordance with the present invention for the suppression of radio interference in an electric motor having at least two brushes comprises a high frequency interference suppression circuit and a low frequency interference suppression circuit, the high frequency interference suppression circuit comprising a ferrite bead which surrounds a portion of a lead connectable to one of the brushes, and a capacitor which is capable of self resonance in the high frequency band, and the low frequency interference suppression circuit comprising a capacitor.

Preferably the low frequency interference suppression circuit includes an additional inductance/high impedance element which is capable of isolating the capacitor of the low frequency interference suppression circuit at high frequencies.

Where the high and low frequency interference suppression circuits are connected to ground, preferably the ground connections are isolated from one another.

The high and low frequency interference suppression circuits are preferably mounted on a printed circuit board, and a predetermined length of track of the printed circuit board preferably defines the additional inductance/high impedence element when present.

The present invention also comprises an electric motor, preferably for automotive applications, having an arrangement as herein described for radio interference suppression.

The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a circuit diagram illustrating a typical previously known arrangement;

Figure 2 is a circuit diagram illustrating an arrangement in accordance with a first embodiment of the present invention for suppression of radio interference from an electric motor; and

Figure 3 is an alternative circuit diagram illustrating an arrangement in accordance with a second embodiment of the present invention.

Referring to Figure 1, there is shown a standard electric motor 10 having three brushes 11, 13, 15 for high speed and low speed operation. Brush 15 is a common brush for low speed brush 11 and high speed brush 13. The circuit elements comprise two inductors 12, 14 in the form of wire-wound chokes; two capacitors 16, 18; a switch 20 having three positions, OFF, LOW and HIGH; and a battery 22 for supplying a d.c. supply voltage to the electric motor 10. Inductor 12 and capacitor 16 provide radio interference suppression for the low speed operation of the electric motor 10; and inductor 14 and capacitor 18 provide radio interference suppression for the high speed operation of the electric motor. The inductors 12, 14 give a high impedance path for the higher frequencies, thereby

providing radio interference suppression for the FM band. The capacitors 16, 18 give a low impedance path for the lower frequencies, thereby providing radio interference suppression for the AM band.

In the arrangement shown in Figure 2, the electric motor 10, switch 20, and battery 22 are as shown in Figure 1. In this arrangement, however, the wire wound chokes have been replaced by ferrite beads 24, 26 and capacitors 28, 30. The ferrite beads 24, 26 (which surround leads 36, 38) have the effect of increasing the inductance of the leads 36, 38, which are connected to the brushes of the electric motor 10, and so perform as an inductor. However, this in itself is not sufficient to attenuate the noise voltage to an acceptable level, so extra capacitors 28, 30 are required. The frequency response of the ferrite beads 24, 26 is relatively flat, with little or no resonance. The value of the capacitors 28, 30 is therefore chosen such that they self resonate at about 100 MHz (around the mid-point of the FM band) The ferrite beads 24, 26 contribute to this resonance to give a wider bandwidth of attenuation (preferably of at least 35dB) to provide suppression over the whole of the FM band.

Capacitors 32, 34 which are used for radio interference suppression at lower frequencies can, however, (as they are connected in parallel with capacitors 28, 30) have an effect on the resonance on the capacitors 28, 30 causing a loss of attenuation, and a change in the resonant frequency of the capacitors 28, 30. This effect is due to the inductive effect of the capacitors 32, 34 and the leads connected thereto which can reduce the Q and bandwidth, causing a reduction in the attenuating properties of the ferrite beads 24, 26/capacitors 28, 30 circuit.

As a further improvement to the present invention, therefore, the capacitors 32, 34 are effectively isolated from the ferrite beads 24, 26/capacitors 28, 30 circuit as shown in Figure 3. In this arrangement, the ferrite beads 24, 26/capacitors 28, 30 circuit (which define a high frequency interference suppression circuit) are grounded separately from the capacitors 32, 34 (which define a low frequency interference suppression circuit). Further, an additional inductive/high impedance element 40, 42 is included which minimises the effective loading of the capacitors 32, 34 on the ferrite beads 24, 26/capacitors 28, 30 circuit, and thereby effectively isolates the capacitors 32, 34 from the high frequency interference suppression circuit.

By providing separate grounds, common impedance coupling between the capacitors 28, 30 and 32, 34 is reduced.

At high frequencies the additional inductance/high impedance elements 40, 42 are preferably such as to present an inductive reactance of 200 ohms, effectively isolating the capacitors 32, 34 (which typically have an impedance of 20 ohms at high frequency) from the low impedence (approximately 3 ohms) presented by the resonating ferrite beads 24, 26/capacitors 28, 30 circuit. This allows the value of capacitors 28, 30 to be kept low, thereby increasing the attenuation. The length of the leads 44, 46 between the capacitors 28, 30 and ground is preferably kept as short as possible to ensure impedance is kept to a minimum.

In an example of the arrangement in Figure 3, the circuit is assembled on a printed circuit board. Capacitors 32, 34 are 1 microfarad capacitors having a wound or stacked foil construction. Capacitors 28, 30 are 470 pF ceramic plate capacitors. Ferrite beads 24, 26 are 16 mm long and 6 mm in diameter. The additional inductance/high impedence elements 40, 42 is provided by a predetermined length of track on the printed circuit board. This arrangement allows automatic assembly of the circuit. When used with, for example, a two speed windscreen wiper motor, the printed circuit board can be mounted within the housing of the motor with the capacitors 32, 34 connected on one side to the ground for the common brush 15 of the motor, and the capacitors 28, 30 connected on one side to the ground provided by the housing of the motor.

Using the present invention, the size of the capacitors 32, 34 for low frequency interference suppression can be reduced over previously known arrangements, hence reducing cost; the use of ferrite beads is considerably cheaper than wire-wound chokes; and the present intention lends itself to automatic assembly.

Claims

1. An arrangement for the suppression of radio interference in an electric motor (10) having at least two brushes (11,13), the arrangement comprising a high frequency interference suppression circuit and a low frequency interference suppression circuit, characterised in that the high frequency interference suppression circuit comprising a ferrite bead (24,26) which surrounds a portion of a lead (36,38) connectable to one of the brushes (11,13), and a capacitor (28,30) which is capable of self resonance in the high frequency band, and the low frequency interference suppression circuit comprising a capacitor (32,34).

2. An arrangement as claimed in Claim 1, wherein the low frequency interference suppression circuit further comprises an additional inductive/high impedance element (40,42) which is

capable of isolating the capacitor (32,34) of the low frequency interference suppression circuit at high frequencies.

3. An arrangement as claimed in Claim 1 or Claim 2, wherein the high and low frequency interference suppression circuits are connected to ground, and the ground connections are separated from one another.

4. An arrangement as claimed in any one of Claims 1 or 3, wherein the high and low frequency interference suppression circuits are mounted on a printed circuit board.

5. An arrangement as claimed in Claim 4 including an additional inductive/high impedance element in the low frequency interference suppression circuit, wherein the additional inductive/high impedance element comprises a predetermined length of track on the printed circuit board.

6. An electric motor having an arrangement as claimec in any one of Claims 1 to 5 connected thereto for providing radio interference suppression.

7. An electric motor as claimed in Claim 6 for use in automotive applications.

Fig. 1.

PRIOR ART.

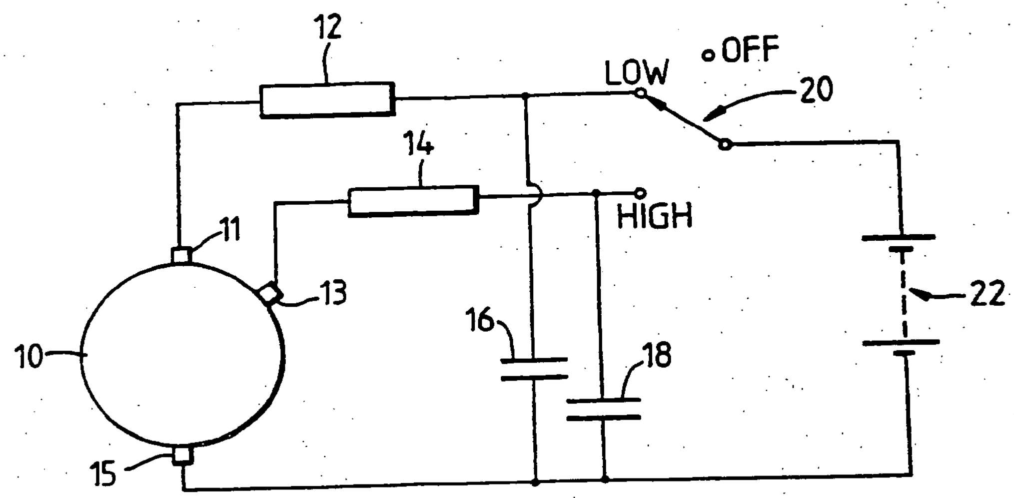


Fig. 2.

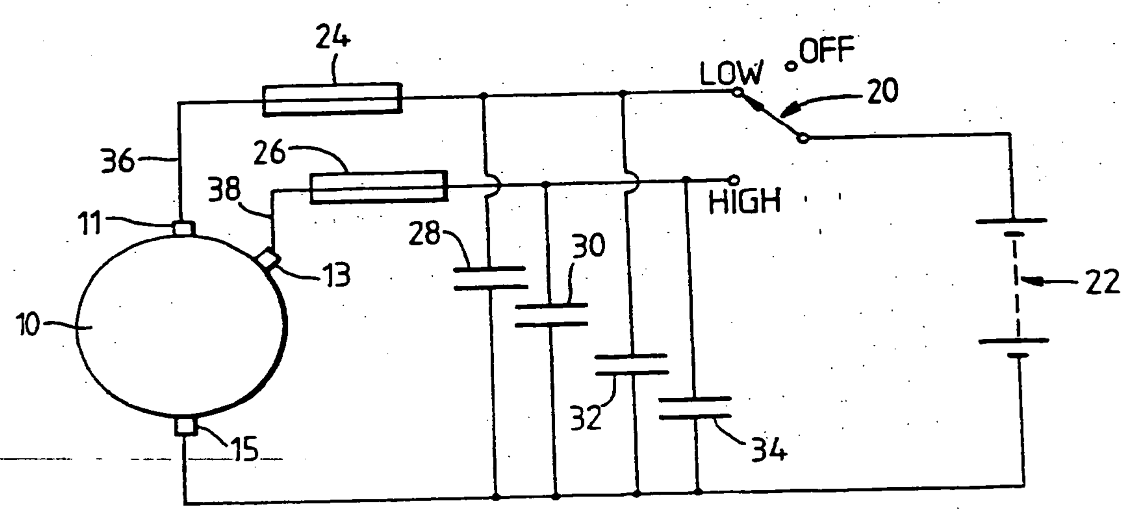
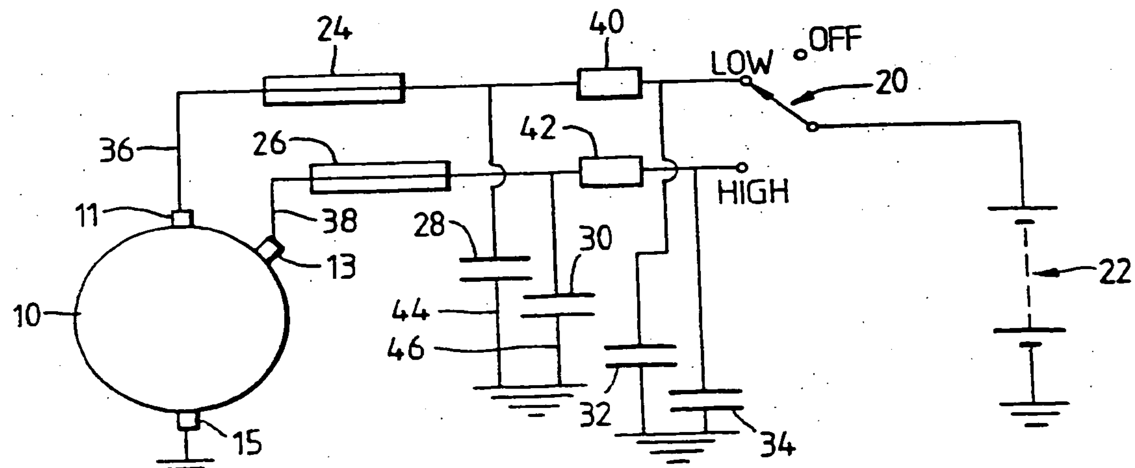


Fig. 3.



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24.05.88 GB 8812283

(43) Date of publication of application:
11.10.89 Bulletin 89/41

(84) Designated Contracting States:
DE ES FR SE

(88) Date of deferred publication of the search report:
12.12.90 Bulletin 90/50

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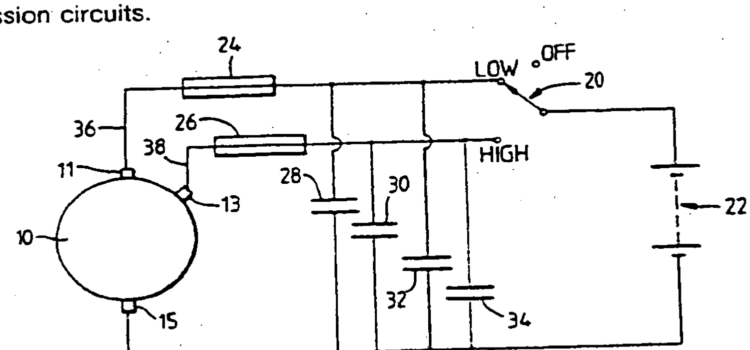
Fig. 2.



European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 30 1113

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	PHILIPS MATRONICS. no. 11, November 1956, EINDHOVEN NL pages 189 - 196; H. Krützfeld: "Some Applications of Ferroxcube at Very High Frequencies (VHF)" * page 192, right-hand column, line 22 - page 193, right-hand column, line 11; figures 10, 11 *	1, 6, 7	H02K11/00
Y	US-A-4329605 (D. F. ANGI; W. D. CORNWELL) * column 1, line 55 - column 2, line 6 * * column 3, lines 30 - 37 * * column 5, lines 1 - 40 *	1, 6, 7	
A		2-4	
A	US-A-3924147 (V. K. TARNOW; K. E. DOSHIER) * abstract; figures 6, 7, 11, 12 *	1, 4, 6	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

H02K
H04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	01 OCTOBER 1990	ZANICHELLI F.

CATEGORY OF CITED DOCUMENTS

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